

Claims

1. A composite fiber, comprising: a composition comprising 100 parts by weight of a wholly aromatic polyamide mainly comprising structural units of the following general formulae (A) and (B):



where in the general formulae (A) and (B), Ar^1 and Ar^2 each independently represent a bivalent aromatic group having 6 to 20 carbon atoms; and 0.01 to 100 parts by weight of carbon nanotubes with an average diameter of 300 nm or less, and an average aspect ratio of 5.0 or more, characterized in that the carbon nanotubes are oriented in the fiber axis direction.

2. The composite fiber according to claim 1, characterized in that the carbon nanotubes are multiwall carbon nanotubes, and the orientation factor F of the carbon nanotubes determined with the following formula (1):

$$\begin{aligned} \langle \cos^2 \phi \rangle &= \frac{\int_0^{\pi/2} I(\phi) \cos^2 \phi \sin \phi d\phi}{\int_0^{\pi/2} I(\phi) \sin \phi d\phi} \\ F &= \frac{3 \langle \cos^2 \phi \rangle - 1}{2} \end{aligned} \quad (1)$$

where ϕ represents the azimuth in an X-ray diffraction measurement, and I represents the diffraction strength of the 002 crystal face, is 0.1 or more.

3. The composite fiber according to claim 1, characterized in that in the Raman spectrum derived from the carbon nanotubes when an incoming laser has been applied from the direction orthogonal to the fiber axis to the side of the fiber, the orientation degree P represented by the following formula (2):

$$P = I_{YY}/I_{XX} \quad (2)$$

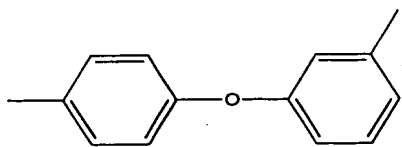
where in the formula, I_{XX} represents the G-band strength when the laser polarization plane has been arranged in parallel with the fiber axis, and I_{YY} represents the G-band strength when the laser polarization plane has been arranged vertically to the fiber axis,

satisfies the range of 0 or more and 0.7 or less.

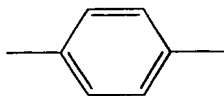
4. The composite fiber according to claim 1, wherein the wholly aromatic polyamide is such that Ar^1 is:



and/or

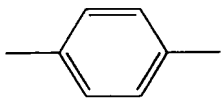


and such that Ar^2 is:

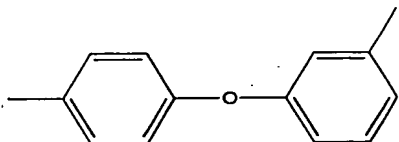


5. The composite fiber according to claim 4, wherein the

wholly aromatic polyamide is a copolymer in which Ar¹ is:



and



and, Ar² is :



and the copolymerization ratio is 1 : 0.8 to 1 : 1.2.

6. The composite fiber according to claim 2 or 3, wherein the orientation factor F of the wholly aromatic polyamide which can be determined by the formula (1) is 0.5 or more.

7. The composite fiber according to claim 1, wherein the proportion of the oxygen atoms present on the surface of the carbon nanotube to be used is in the range of 2 to 25 per 100 of carbon atoms.

8. The composite fiber according to claim 1, wherein the carbon nanotubes to be used are the ones subjected to a physical size reduction treatment.

9. The composite fiber according to claim 1, wherein the carbon nanotubes to be used are the ones subjected to a treatment with a strong acid having a pH of 0.01 to 2.

10. The composite fiber according to claim 1, using

carbon nanotubes which have been esterified, following a treatment with a strong acid having a pH of 0.01 to 2.

11. The composite fiber according to claim 1, using carbon nanotubes which have been amidated, following a treatment with a strong acid having a pH of 0.01 to 2 and esterification.

12. A method for manufacturing the composite fiber according to claim 1, characterized by preparing a mixed solution of a wholly aromatic polyamide and carbon nanotubes, and performing spinning from the solution to orient the carbon nanotubes.

13. The method for manufacturing the composite fiber according to claim 12, using carbon nanotubes subjected to a physical size reduction treatment.

14. The method for manufacturing the composite fiber according to claim 12, using carbon nanotubes subjected to a treatment with a strong acid having a pH of 0.01 to 2.

15. The method for manufacturing the composite fiber according to claim 12, using carbon nanotubes which have been esterified, following a treatment with a strong acid having a pH of 0.01 to 2.

16. The method for manufacturing the composite fiber according to claim 12, using carbon nanotubes which have been amidated, following a treatment with a strong acid having a pH of 0.01 to 2, and esterification.